

An Independent Scientific Assessment of Well Stimulation in California

Volume II

Potential Environmental Impacts of Hydraulic Fracturing and Acid Stimulations

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CCST is a non-profit organization established in 1988 at the request of the California State Government and sponsored by the major public and private postsecondary institutions of California and affiliate federal laboratories in conjunction with leading private-sector firms. CCST's mission is to improve science and technology policy and application in California by proposing programs, conducting analyses, and recommending public policies and initiatives that will maintain California's technological leadership and a vigorous economy.

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Acronyms and Abbreviations

AACOG	Alamo Area County of Governments
ACGIH	American Conference of Governmental Industrial Hygienists
ACS	American Chemical Society
ACToR	Aggregated Computational Toxicology Resource
ADSA	Axial Dimensional Stimulation Area
ANSS	Advanced National Seismic System
APCD	Air Pollution Control District
API	American Petroleum Institute
AQMD	Air Quality Management District
ATSDR	Agency for Toxic Substances and Disease Registry
ATV	All-Terrain Vehicles
AXPC	American Exploration and Production Council
bbl	Barrels
BC	Black Carbon
BLM	Bureau of Land Management
BLS	(U.S.) Bureau of Labor Statistics
BO	Biological Opinion
BOD5	Biological Oxygen Demand
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
C ₂ H ₆	Ethane
CALGEM	California Greenhouse Gas Emissions Measurement program
CalOSHA	California Occupational Safety and Health Administration
CalWIMS	California Well Information Management System
CARB	California Air Resources Board
CAS	Chemical Abstracts Service
CASRN	Chemical Abstracts Service Registry Number
CDFW	California Department of Fish and Wildlife
CDPH	California Department of Public Health
CEIDARS	California Emission Inventory Development and Reporting System
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CGS	California Geological Survey
CH ₄	Methane
CHRIP	Chemical Risk Information Platform
CNDDB	California Natural Diversity Database

Acronyms and Abbreviations

CO	Carbon Monoxide
CO ₂	Carbon Dioxide
CO ₂ eq.	CO ₂ -equivalent
COD	Chemical Oxygen Demand
CTI	California Toxics Inventory
CTMs	Chemical Transport Models
CVRWQCB	Central Valley Regional Water Quality Control Board
CWD	Cawelo Water District
dB	Decibels
dBA	A-Weighted Decibels
DBNPA	2,2-dibromo-3-nitropropionamide
DFW	Department of Fish and Wildlife
DOC	(California) Department of Conservation
DOGGR	Division of Oil, Gas, and Geothermal Resources
DOORS	Diesel Off-road On-line Reporting System
DWR	Department of Water Resources
EC	Electrical Conductivity
EC ₅₀	Median Effective Concentration
ECHA	European Chemicals Agency
EDC	Endocrine Disrupting Compounds
EDGAR	Emissions Database for Global Atmospheric Research
EDTA	Ethylenediaminetetraacetic Acid
EGS	Enhanced Geothermal System
EHM	Estimated Hazard Metric
EOR	Enhanced Oil Recovery
EPI	Estimation Program Interface
ERCB	Energy Resources Conservation Board
ERG/SAGE	Eastern Research Group, Inc. and Sage Environmental Consulting LP
ESA	Endangered Species Act (Federal)
EU	European Union
EWQL	Environmental Water Quality Laboratory
GAMA	Groundwater Ambient Monitoring and Assessment
GAO	U.S. Government Accountability Office
GHG	Greenhouse Gas
GHGRP	Greenhouse Gases Reporting Program
GHS	Globally Harmonized System
GIS	Geographic Information System
GWP	Global-Warming Potential
H ₂ S	Hydrogen Sulfide
HAP	Hazardous Air Pollutants

Acronyms and Abbreviations

HBACV	Health-Based Air Comparison Values
HC	Hydrocarbon
HCl	Hydrochloric Acid
HCP	Habitat Conservation Plan
HCF	Hydrofluorocarbons
HF	Hydrofluoric Acid
HI	Hazard Indices
HSDB	Hazardous Substance Data Bank
IARC	International Agency for Research on Cancer
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IRIS	Integrated Risk Information System
IUCLID	International Uniform Chemical Information Database
LBL	Lawrence Berkeley National Laboratory
LC ₅₀	Median Lethal Concentration
LCA	Life Cycle Assessment
LCFS	Low Carbon Fuel Standard
LD ₅₀	Median Lethal Dose
LPG	Liquefied Petroleum Gas
MADL	Maximum Allowable Dose Levels
MBNPA	2-bromo-3-nitropropionamide
MCL	Maximum Contaminant Level
MF	Microfiltration
MIT	Methylisothiazolinone
MITI	Ministry of International Trade and Industry
MRL	Minimal Risk Levels
MRR	Mandatory Reporting Regulation
MSDS	Material Safety Data Sheets
MTBE	Methyl Tertiary Butyl Ether
N ₂ O	Nitrous Oxide
NEPA	National Environmental Policy Act
NETL	National Energy Technology Laboratory
NF	Nanofiltration
NGWA	National Groundwater Association
NIOSH	National Institute for Occupational Safety and Health
NIOSH REL	NIOSH Reference Exposure Level
NMVOC	Non-Methane Volatile Organic Compounds
NORM	Naturally Occurring Radioactive Materials
NO _x	Nitrogen Oxides
NP	Not Practical

Acronyms and Abbreviations

NPDES	National Pollution Discharge Elimination System
NRC	National Research Council
NSRL	No Significant Risk Levels
NYSDEC	New York State Department of Environmental Conservation
OC	Organic Carbon
OCS	(Federal) Outer Continental Shelf
OECD	Organization for Economic Cooperation and Development
OEHHA	Office of Environmental Health Hazard Assessment
OES	Office of Emergency Services
OPGEE	Oil Production Greenhouse Gas Emissions Estimator
OSHA	Occupational Safety and Health Administration
OSPAR	Oslo-Paris Convention, also known as the Convention for the Protection of the Marine Environment of the North-East Atlantic
PA	Planning Area
PA DEP	Pennsylvania Department Of Environmental Protection
PAH	Polycyclic Aromatic Hydrocarbons
PBZ	Personal Breathing Zone
PEL	Permissible Exposure Limits
PFC	Perflouorocarbons
PHG	Public Health Goals
PM	Particulate Matter
POTW	Publicly Owned Treatment Works
PPE	Personal Protective Equipment
ppm	Parts Per Million
PSE	PSE Healthy Energy
PSHA	Probabilistic Seismic Hazard Assessment
PSR	Physicians for Social Responsibility
QAC	Quaternary Ammonium Compounds
QCEW	Quarterly Census Of Employment And Wages
REL	Reference Exposure Levels
RfC	Reference Concentrations
RfDs	Reference Doses
RMSE	Root Mean Square Error
RO	Reverse Osmosis
ROG	Reactive Organic Gases
SAF	San Andreas Fault
SB 4	Senate Bill 4
SB 1281	Senate Bill 1281
SC	South Coast
SCAQMD	South Coast Air Quality Management District

Acronyms and Abbreviations

SCEDC	Southern California Earthquake Data Center
SF ₆	Sulfur hexafluoride
SFs	Slope Factors
SIC	Standard Industrial Classification
SJV	San Joaquin Valley
SNMOC	Speciated Non-Methane Organic Compounds
SoCAB	South Coast Air Basin
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAC	Toxic Air Contaminant
TDS	Total Dissolved Solids
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
TLV	Threshold Limit Value
TOC	Total Organic Carbon
TOC	Toxic Organic Compound
TOG	Total Organic Gases
TOXNET	National Library of Medicine, Toxicology Data Network
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
TWA	Time Weighted Average
UCL	Upper Confidence Level
UCSB	University of California, Santa Barbara
UF	Uncertainty Factor
UF	Ultrafiltration
UGRB	Upper Green River Basin
UIC	Underground Injection Control
UR	Unit Risk Values
URE	Unit Risk Estimates
U.S. DOE	U.S. Department of Energy
U.S. EIA	U.S. Energy Information Administration
U.S. EPA	U.S. Environmental Protection Agency
USDW	Underground Source of Drinking Water
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USQFF	United States Quaternary Fault and Fold
V/P	Various/Partial
VOC	Volatile Organic Carbon
WS	Well Stimulation
WST	Well Stimulation Treatment
WTR	Well to the Refinery Entrance Gate